Ecological Benefits of Compensatory Stream Mitigation in Southern West Virginia

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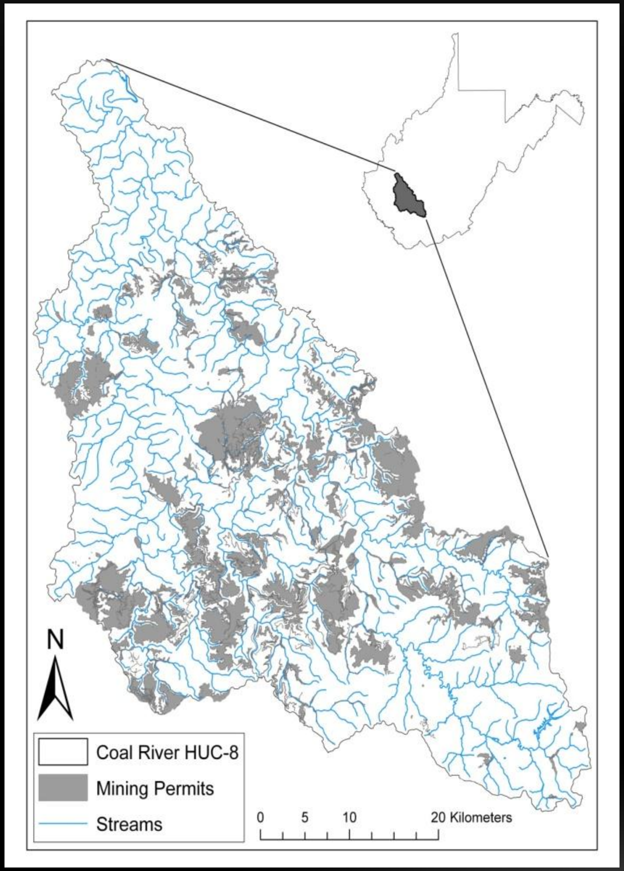
BACKGROUND



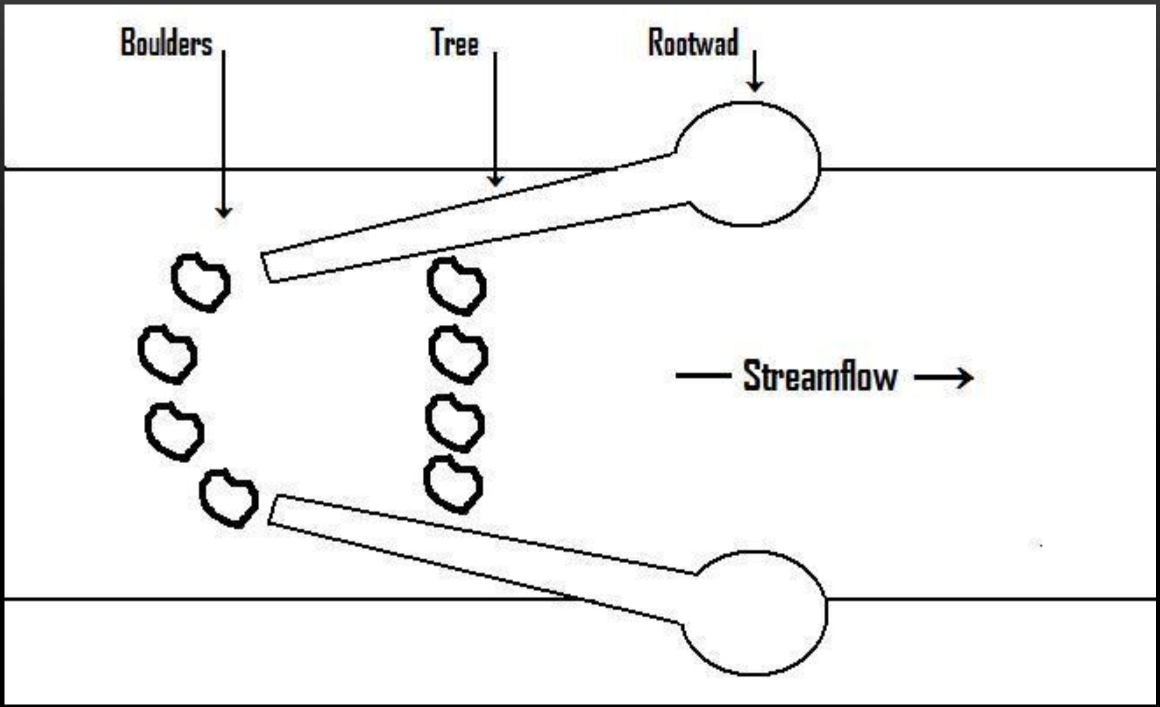
- Drains 384 mi^2
- Nearly 10% of total watershed has been surface mined.
- Nearly 15% is under permit to be mined
- 4400 acres of valley fills(1780 hectares)

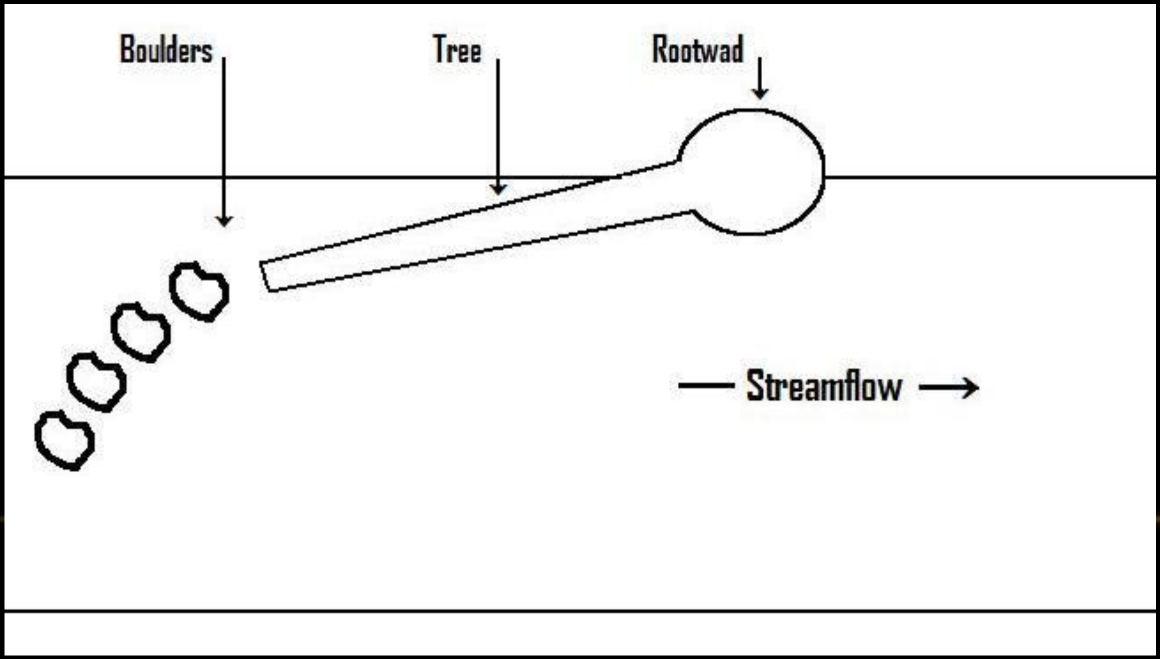
HISTORY

- LCR was used to barge sand from quarries upstream and for cleaning coal
- A highway was constructed from 1972-1973 that follows ~26 km of the Little Coal River mainstem.
- On the USEPA 303(d) list for fecal coliform.
- Compensatory Mitigation for MTM/VF

HABITAT ENHANCEMENT STRUCTURES

- J-hooks, Cross Vanes, and Boulder Clusters.
- Structures put in as mitigation for mining impacts.
- The goal of these structures is to:
  - Reduce width: depth ratio
  - Improve structural complexity
  - Improve aquatic life habitat
  - Improve recreational opportunities
- Effectiveness of structures is unclear
  - Basic functioning
  - As an off-set of HW impacts


Boulders
Tree
Rootwad
Streamflow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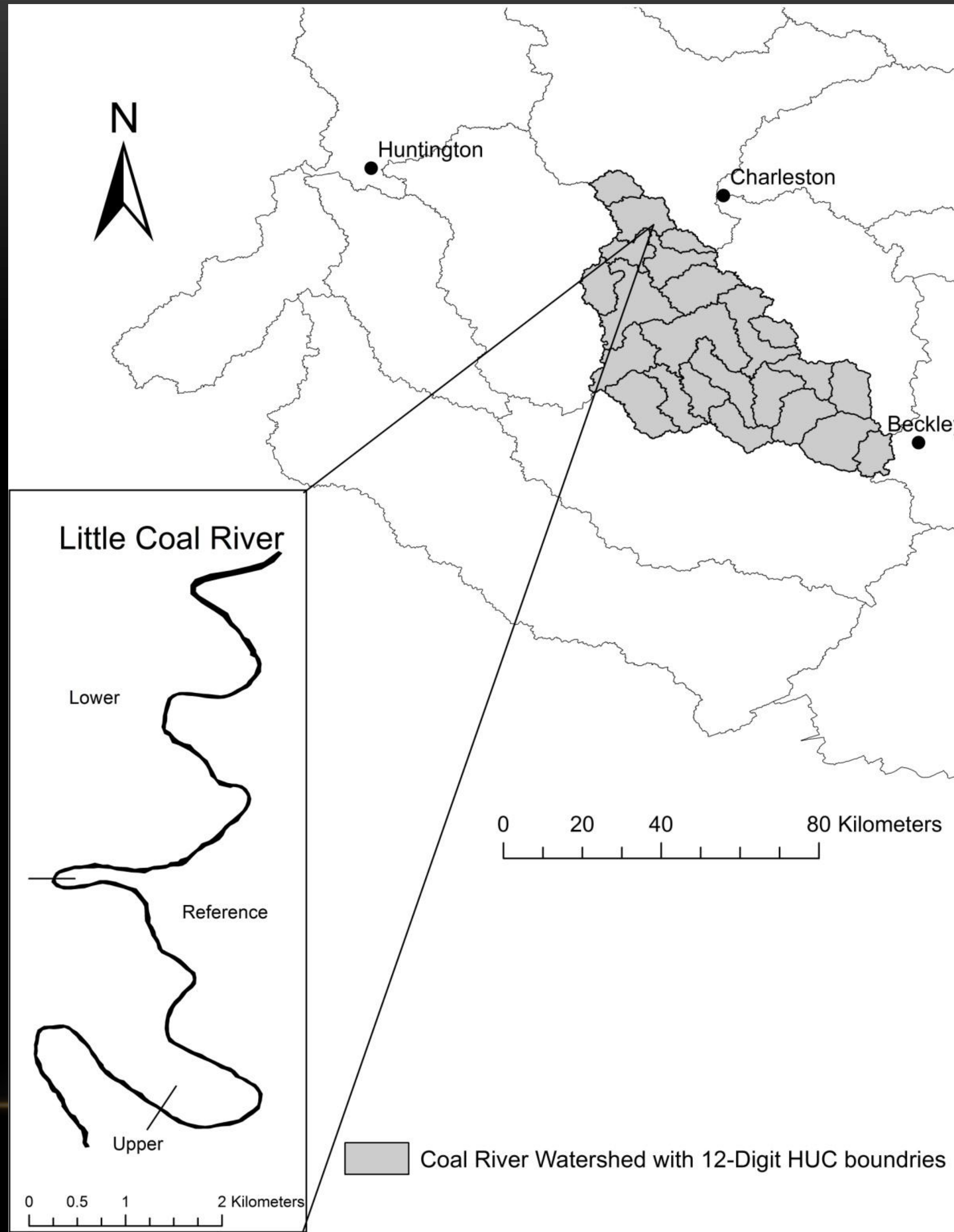
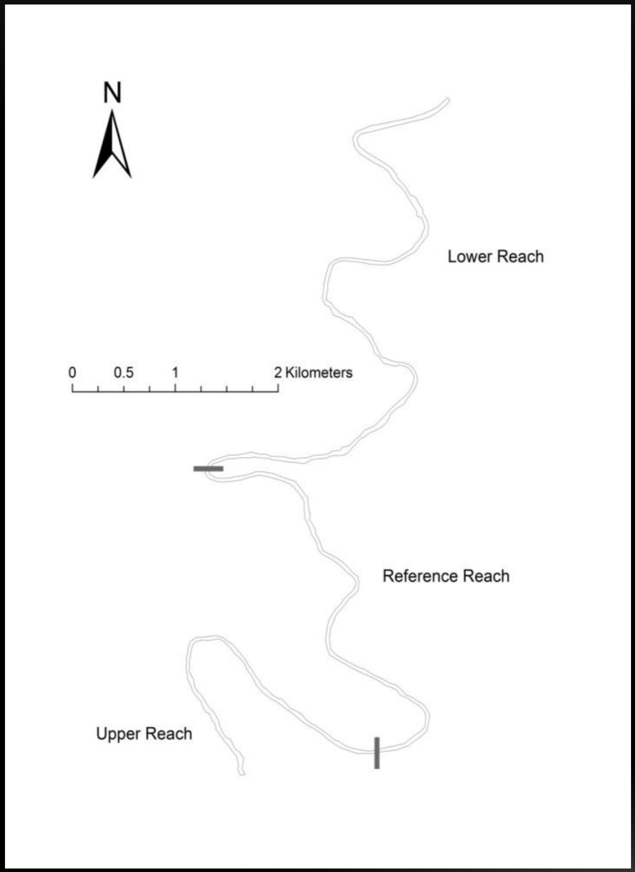

N
Huntington
Charleston
Beckley
Little Coal River
Lower
Reference
Upper
0 0.5 1 2 Kilometers
0 20 40 80 Kilometers
Coal River Watershed with 12-Digit HUC boundries

PRIMARY OBJECTIVES

- **Quantify the physical and biological response of the Little Coal River mainstem to habitat enhancing structures**

- **Evaluate constraints of using HESs in the Little Coal River as mitigation for mining related impacts to HWs**

STUDY DESIGN



- BACI
- Lower Reach
  - 15 structures constructed in June of 2010
- Reference Reach
  - No structures
- Upper Reach
  - 15 structures have been in place for 3-5 years
  - Within each Reach we have Representative Sub-Reaches

PHYSICAL CONDITION MEASUREMENTS

Sediment Maps

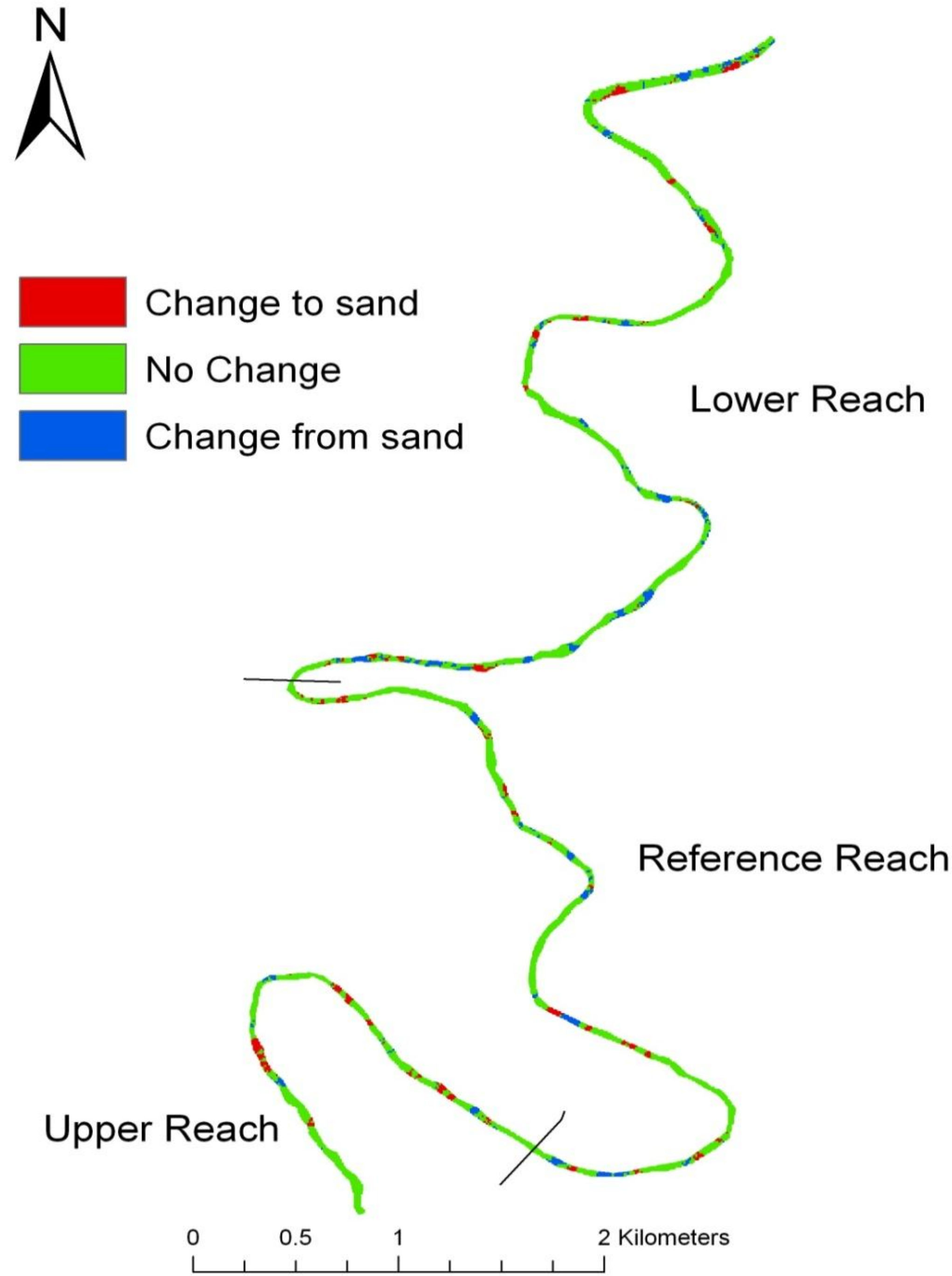
Thalweg Profile/Habitat Quality

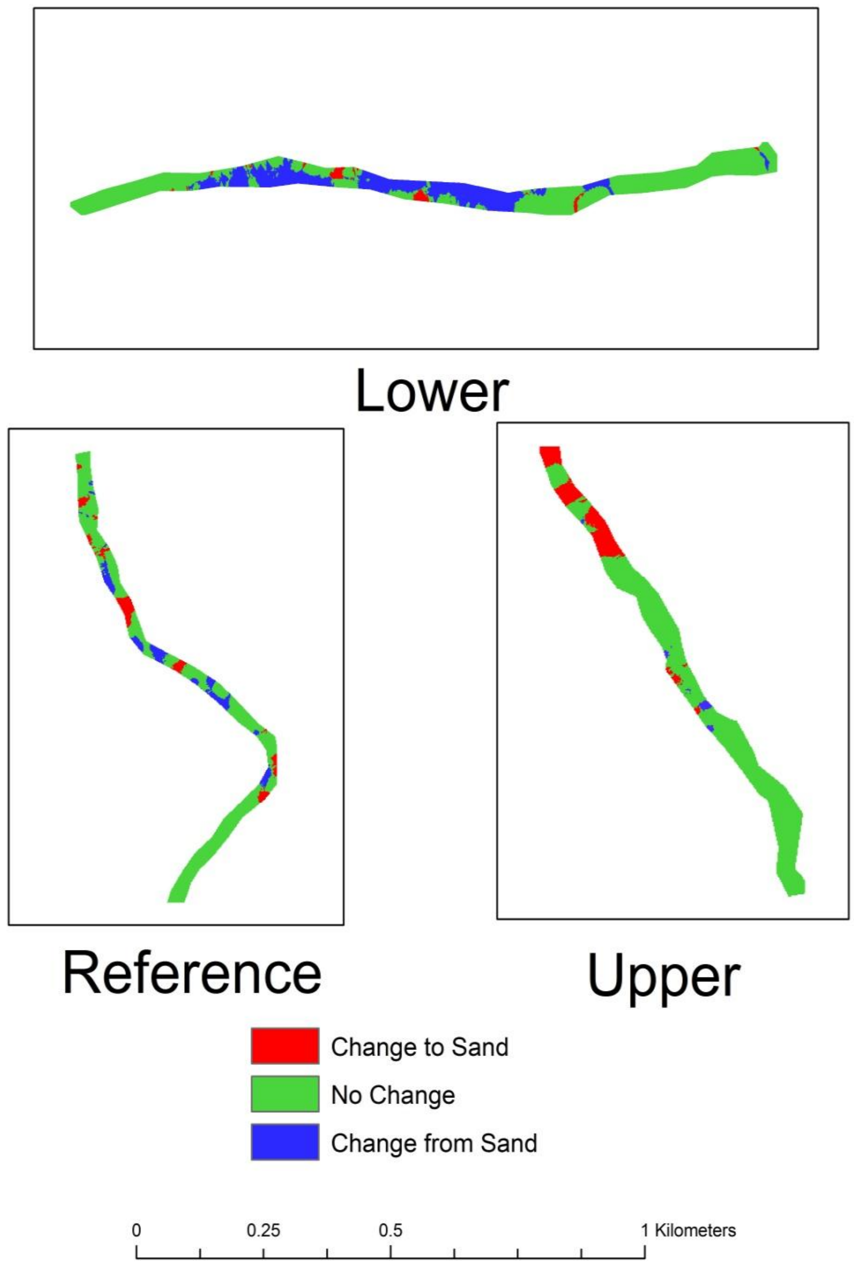
Cross-Sectional Surveys

Longitudinal Profiles

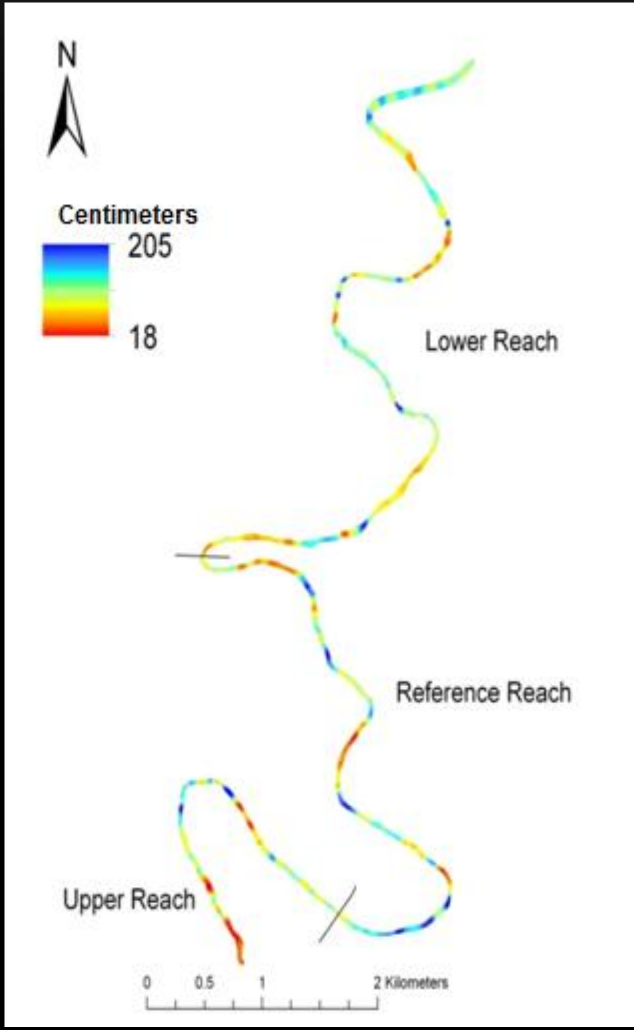
SUBSTRATE

Substrate		Entire River	Upper	Reference	Lower
2009	Sand	48	17	47	61
	Gravel	30	58	32	28
	Cobble	15	19	13	8
	Boulder	7	6	8	3
2010	Sand	51	24	47	46
	Gravel	29	54	30	39
	Cobble	15	19	17	12
	Boulder	5	3	6	3
Change	Sand	+3	+7	0	-15
	Gravel	-1	-4	-2	+11
	Cobble	0	0	+4	+4
	Boulder	-2	-3	-2	0


N
Change to sand
No Change
Change from sand
Lower Reach
Reference Reach
Upper Reach
0
0.5
1
2 Kilometers

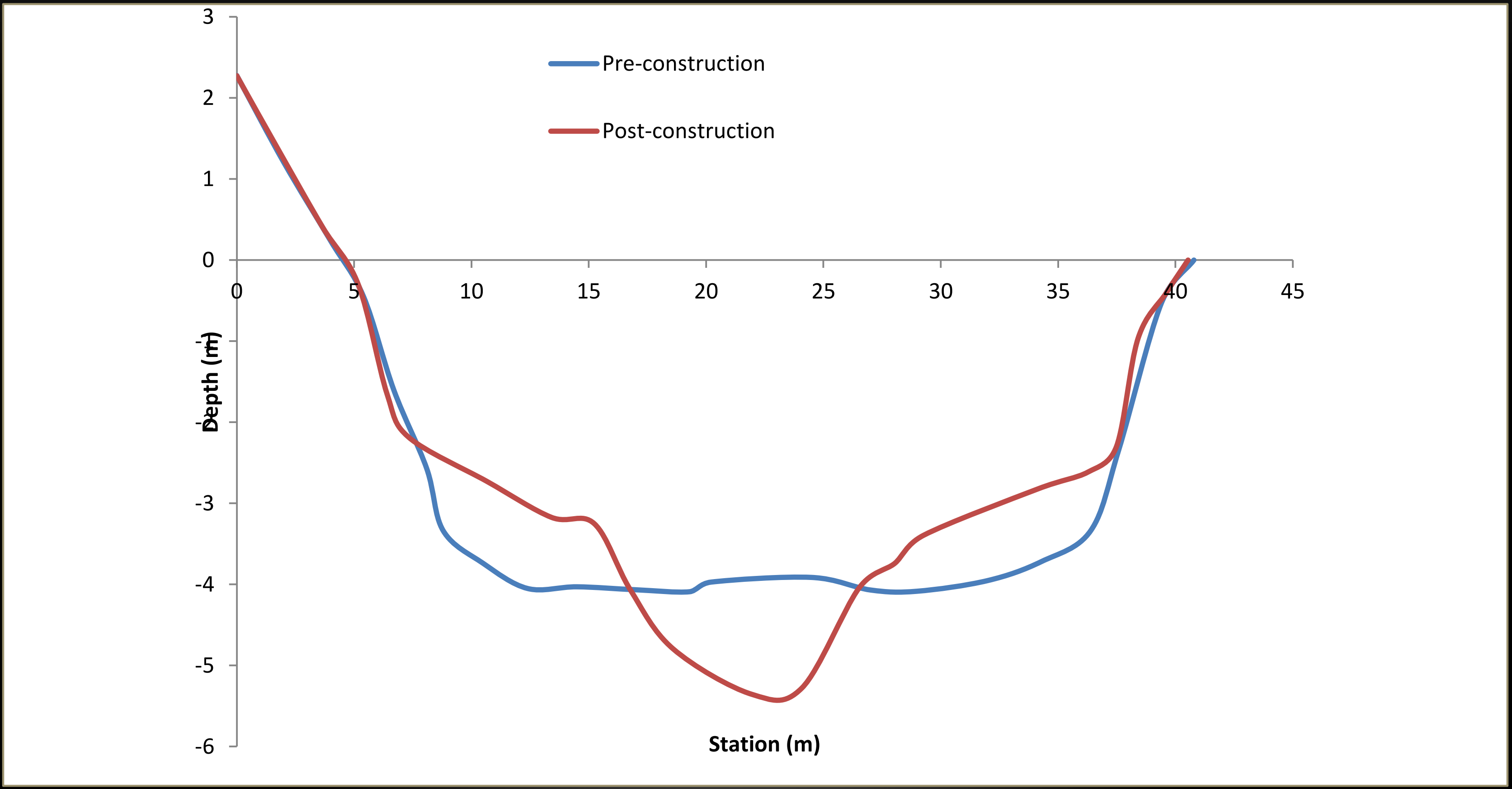

Lower
Reference
Upper
Change to Sand
No Change
Change from Sand
0
0.25
0.5
1 Kilometers

THALWEG PROFILE



	Mean Depth		CV of depth		DFC	
Reach	2009	2010	2009	2010	2009	2010
Entire River	0.93 (0.0072)	0.94 (0.0086)	0.48	0.58	16.15 (0.53)	14.44 (0.59)
Upper	0.56 (0.003)	0.5 (0.0015)	0.92	0.52	16.12 (2.44)	15.24 (1.24)
Reference	0.8 (0.0027)	0.76 (0.0026)	0.59	0.6	12.54 (1.4)	19.69 (2.72)
Lower	0.75 (0.002)	0.92 (0.0026)	0.46	0.48	22.07 (2.45)	11.19 (2.01)

CROSS SECTION

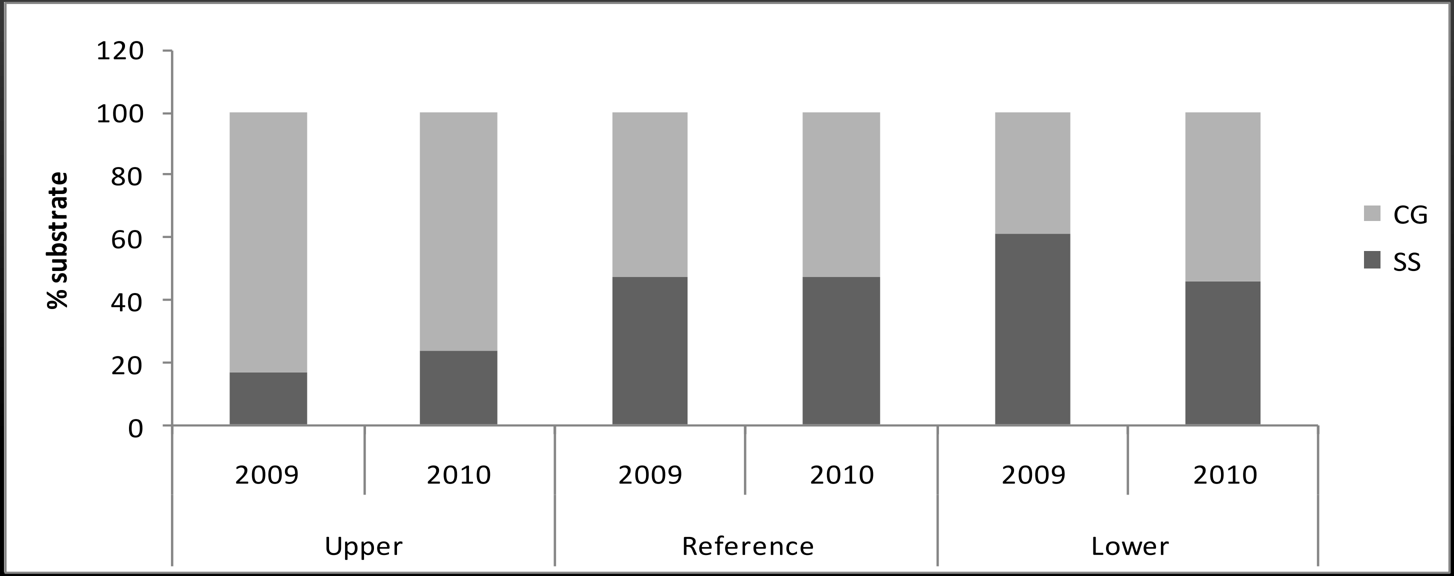


BIOLOGICAL AND CHEMICAL CONDITION MEASUREMENTS

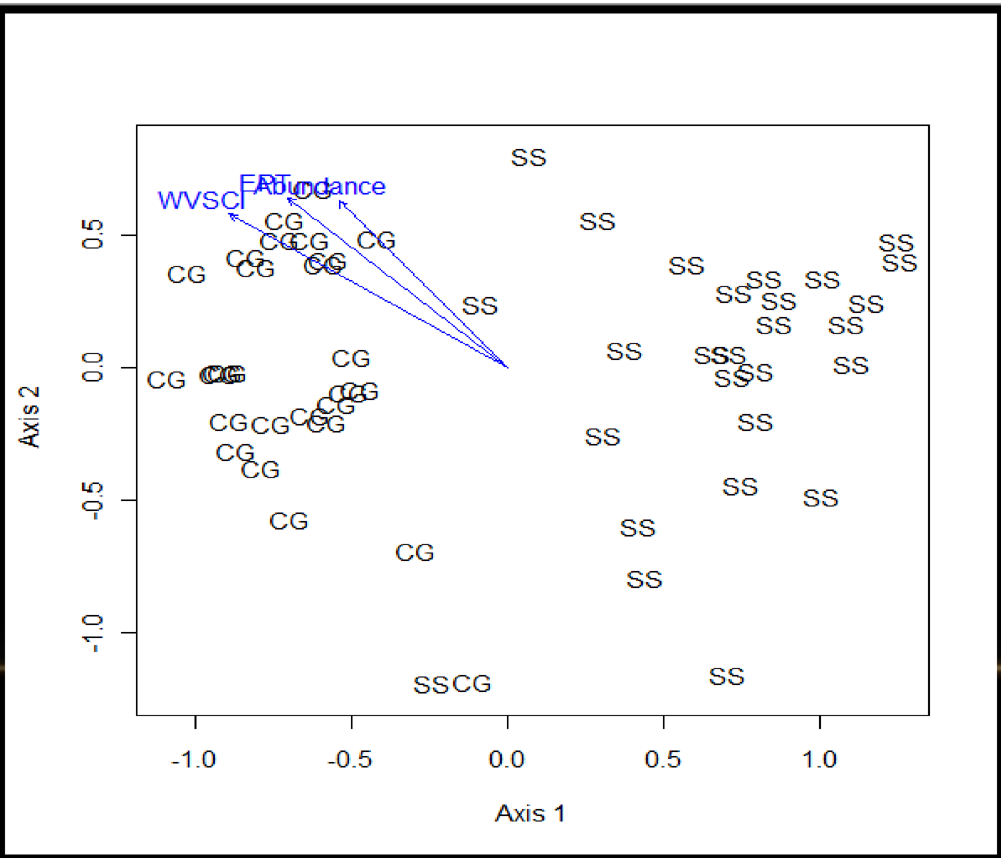
- Water Chemistry
- Macroinvertebrate Assemblages
- Fish Assemblages
- Organic Matter Decomposition

WATER CHEMISTRY

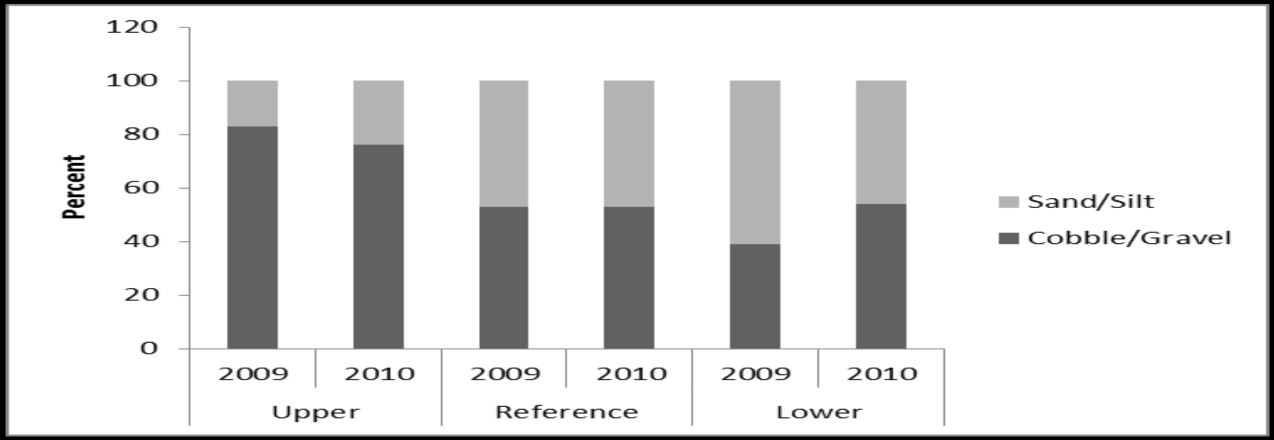
Year	Conductivity	Alkalinity	Ca	Cl	Mg	Na	SO4	TDS	TSS
	Us/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Spring 2009	730	143.58	56.57	13.7	35.79	122.82	224	604	28
Fall 2009	832	234.58	56.35	17.04	34.3	107.94	235	621	19
Spring 2010	704	156.65	47.99	12.88	27.61	76.69	188	480	12
Fall 2010	1060	338.17	37.93	36.5	28.44	201	338	834	2



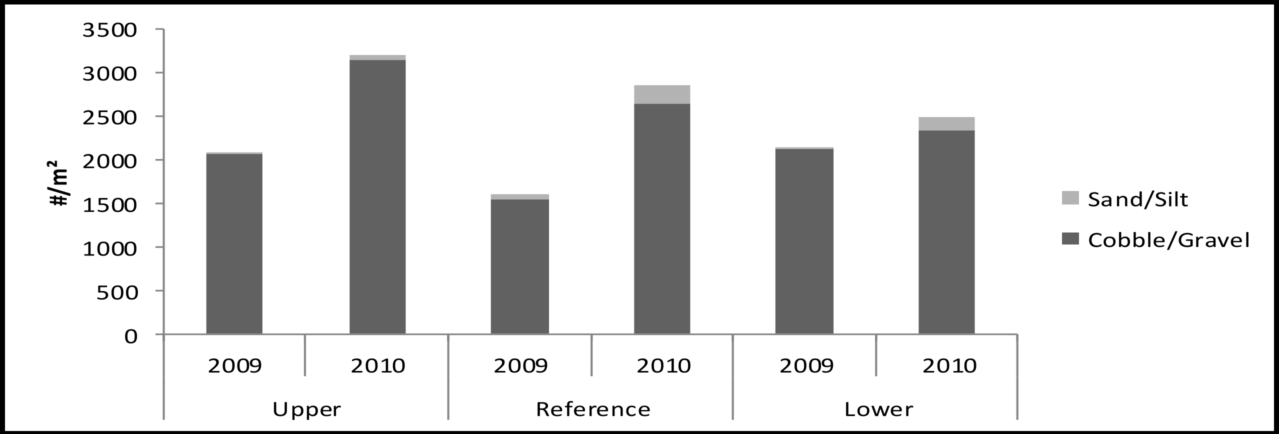
120
100
80
60
40
20
0
% substrate
2009
2010
2009
2010
2009
2010
Upper
Reference
Lower
CG
SS



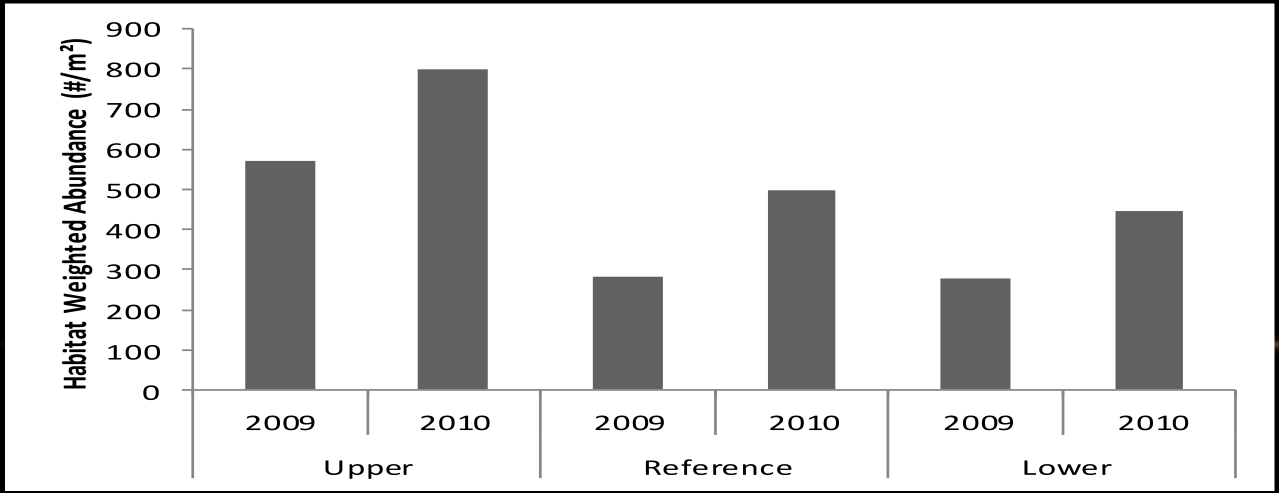
WVSCI
EPT
Abundance
Axis 1
Axis 2
-1.0
-0.5
0.0
0.5
1.0



Percent
120
100
80
60
40
20
0
2009
2010
2009
2010
2009
2010
Upper
Reference
Lower
Sand/Silt
Cobble/Gravel

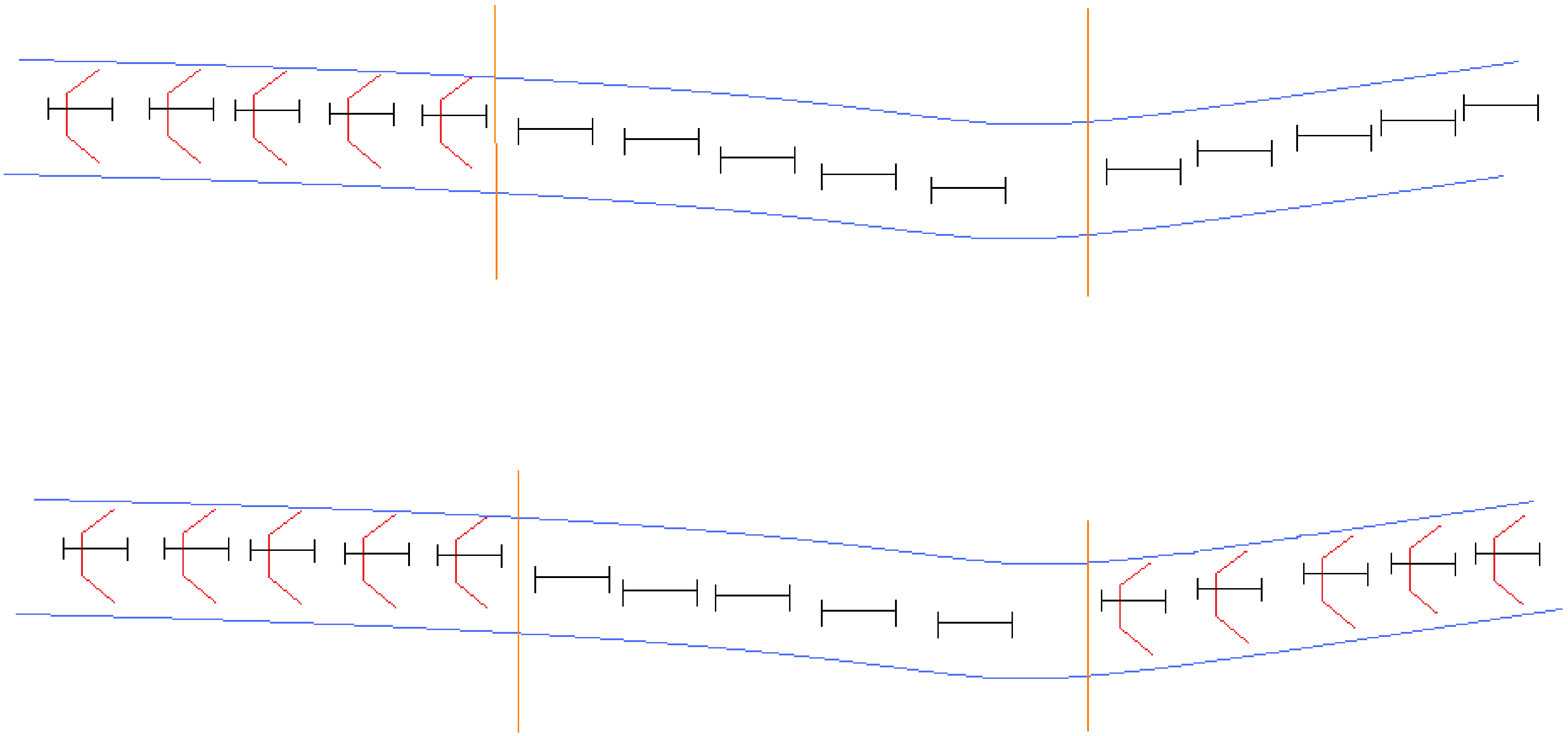


#/m²
3500
3000
2500
2000
1500
1000
500
0
2009
2010
2009
2010
2009
2010
Upper
Reference
Lower
Sand/Silt
Cobble/Gravel

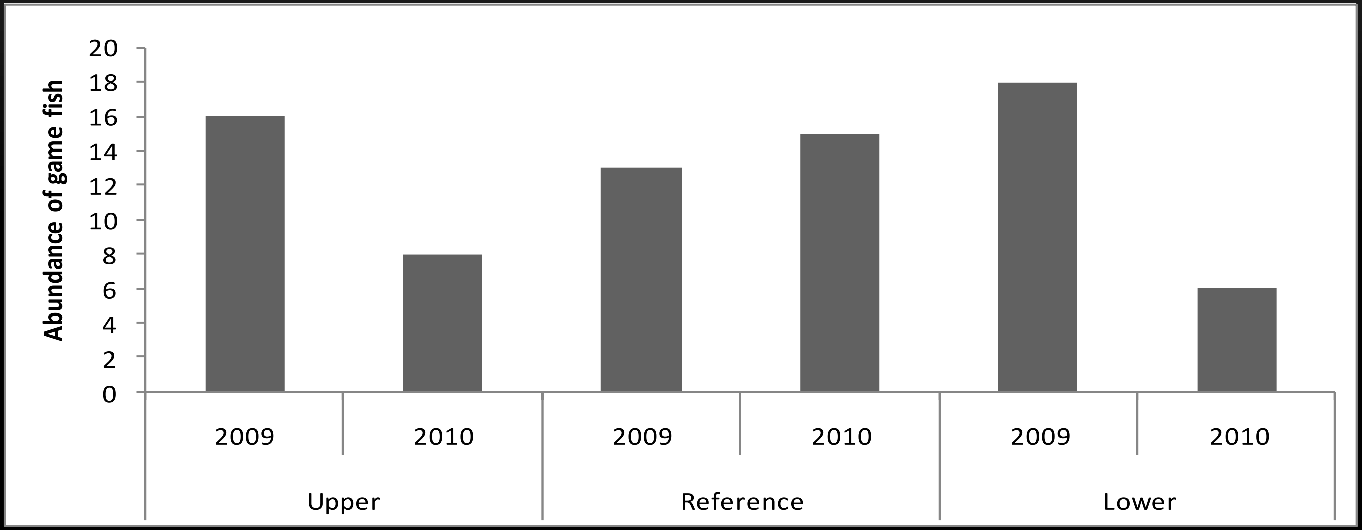


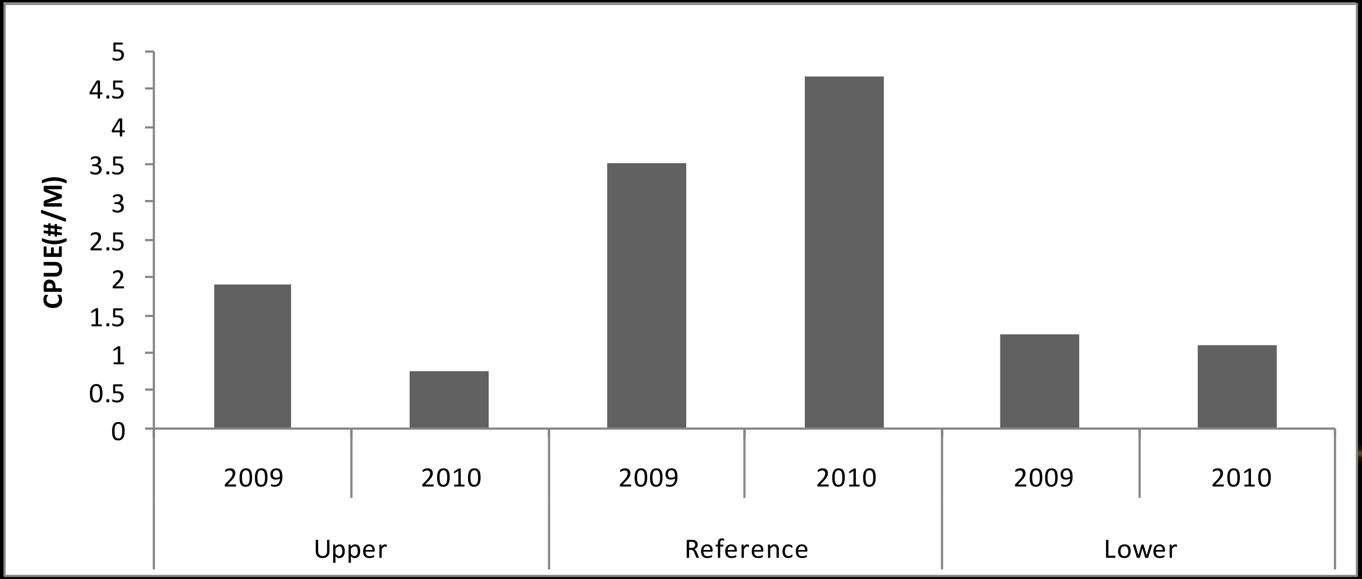
Habitat Weighted Abundance (#/m²)
900
800
700
600
500
400
300
200
100
0
2009
2010
2009
2010
2009
2010
Upper
Reference
Lower

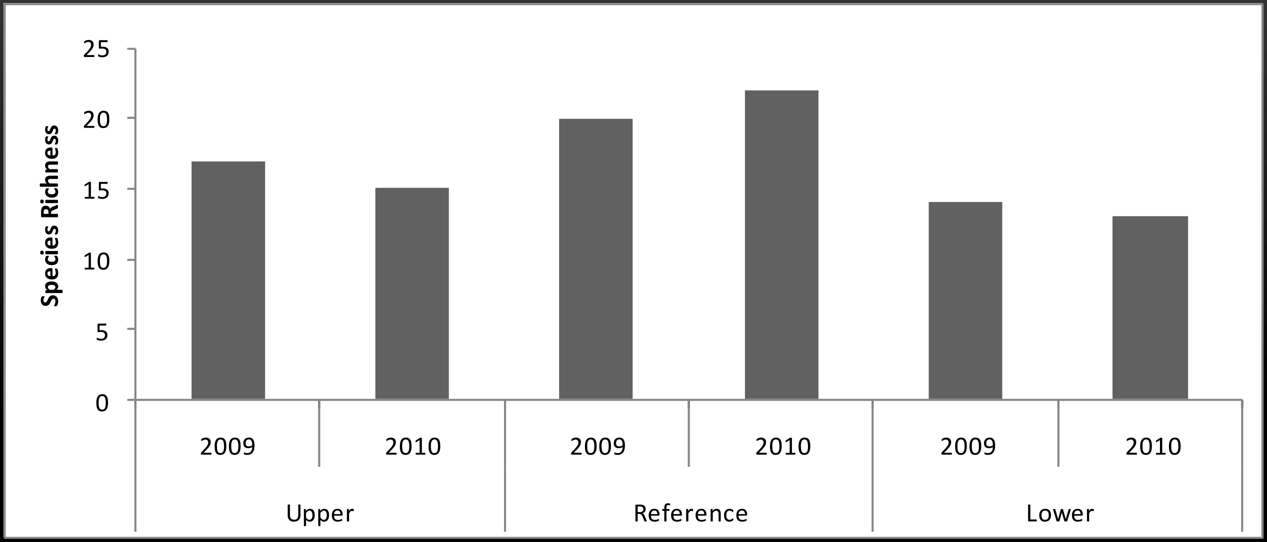
FISH SAMPLING STUDY DESIGN

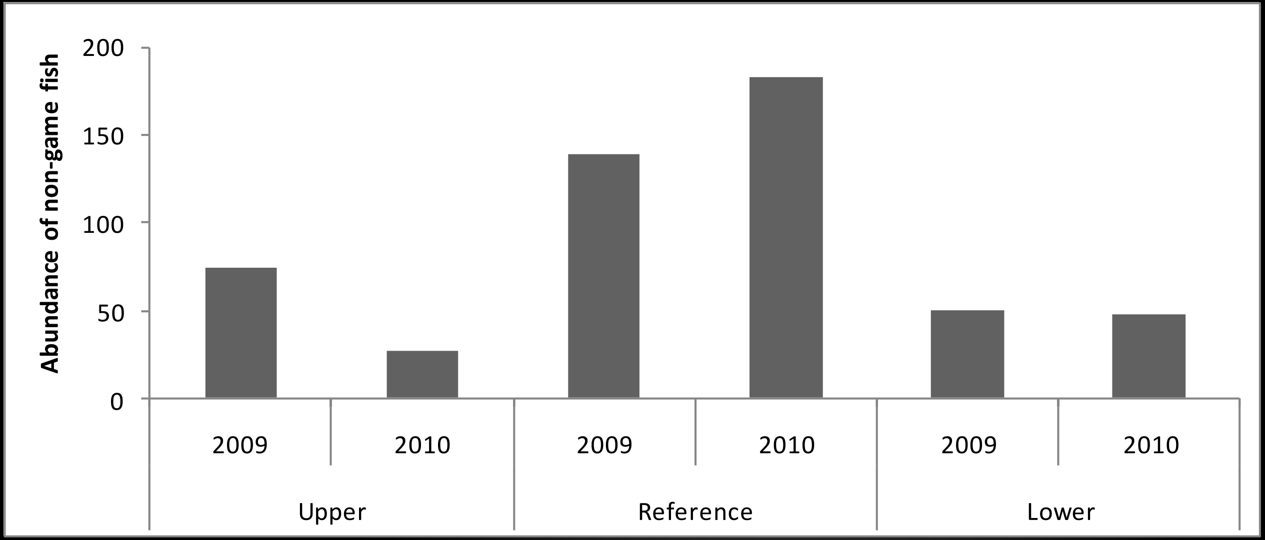


FISH ASSEMBLAGES






Species Richness
25
20
15
10
5
0
2009
2010
2009
2010
2009
2010
Upper
Reference
Lower

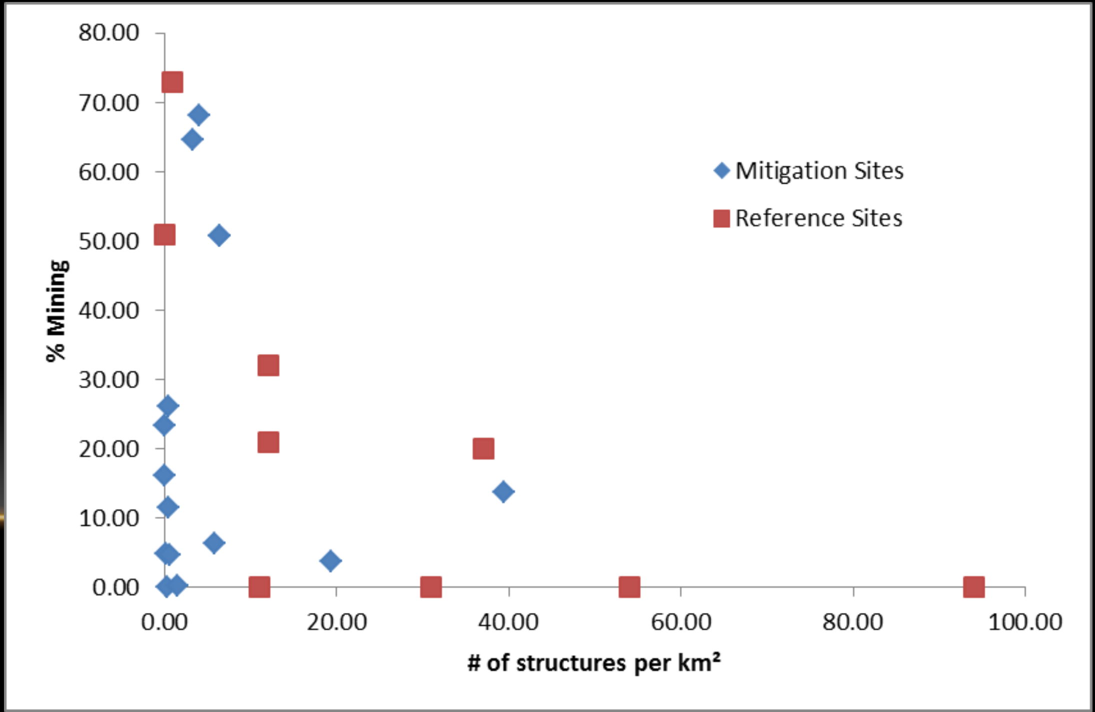

Abundance of non-game fish
200
150
100
50
0
2009
2010
2009
2010
2009
2010
Upper
Reference
Lower

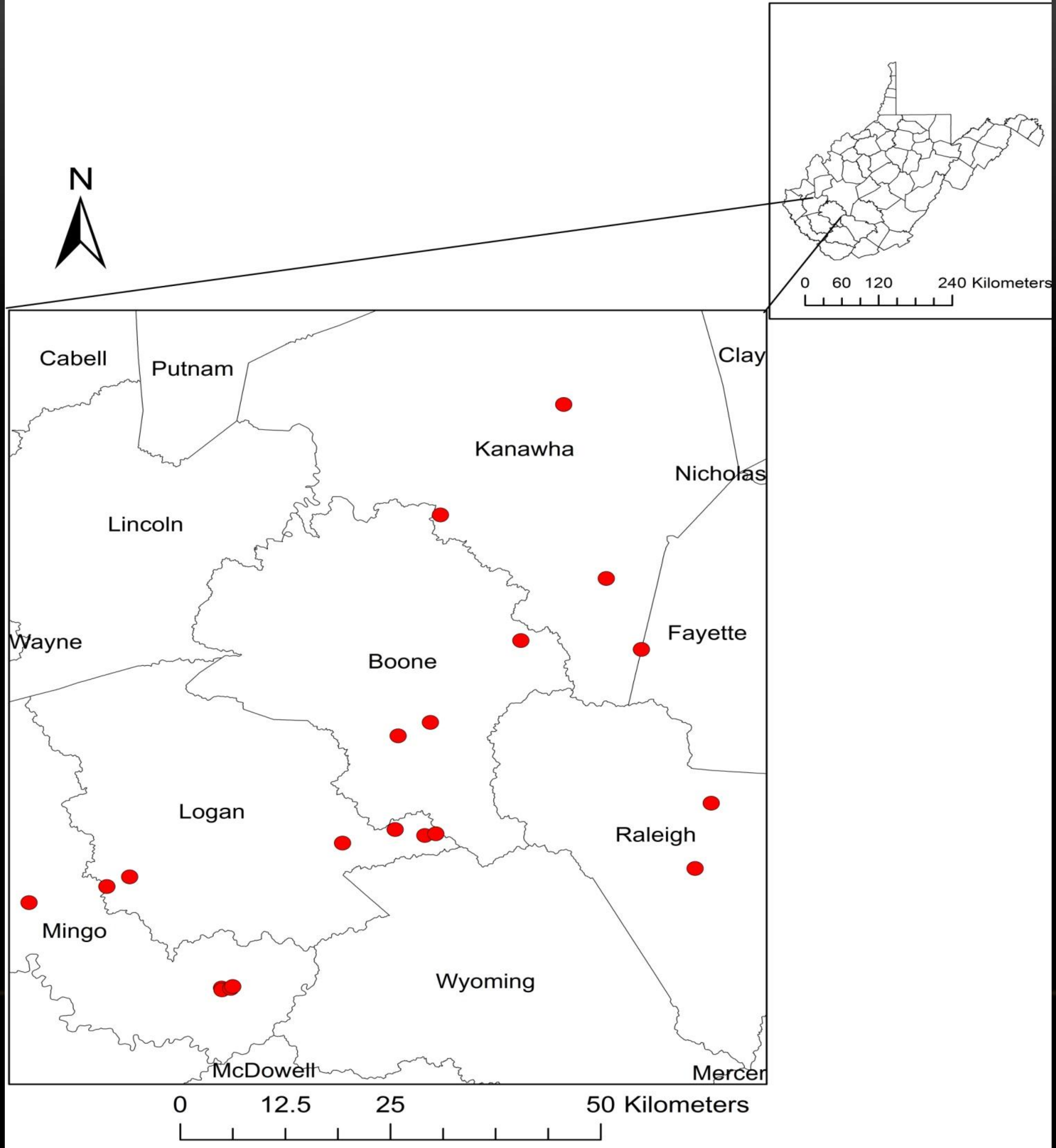
CONCLUSIONS

- HESs produced a measurable change in sediment composition (significant reduction in % sand and increase in % gravel).
- Some evidence that this shift may not persist over time.
- HESs produced a measurable increase in benthic invertebrate biomass and abundance mediated by the change in sediment composition.
- Structures increase stream bed complexity

CREATING A MODEL

- From what we learned about the LCR we will model mitigation to predict alternative futures based on current the current landscape
- 18 mitigated sites from the Southern Coal fields and 8 reference sites were selected
- Measurements were taken at the mitigation and above the mitigation to quantify the benefits of each project





N
0 60 120 240 Kilometers
Cabell
Putnam
Clay
Kanawha
Nicholas
Lincoln
Wayne
Boone
Fayette
Logan
Raleigh
Mingo
Wyoming
McDowell
Mercer
0 12.5 25 50 Kilometers

PINE CREEK

BUFFALO CREEK

DAVIS BRANCH

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CAT
315C